Listing of Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1-18 (canceled)

19. (currently amended) A control program, according to which a laser-beam spot is guided, while being controlled with respect to position and time, over a cornea to be corrected, so as to ablate a predetermined ablation profile therefrom,
wherein the control program takes into account the effect of the angle between the laser beam (68) and the corneal surface on the energy density of the laser-beam spot incident on the corneal surface,
wherein the time interval the laser-beam spot is incident on the corneal surface at an incident point (58) of the corneal surface is increased as a function of the distance (r) of the incident point (58) of the laser-beam spot centre on the cornea (54) from an axis running parallel to the laser-beam direction which axis meets the corneal surface at a right angle (z axis),
~~Control program according to claim 1 or 18, characterised in that,~~ wherein the effect of the distance r of the incidence point (58) of the laser-beam spot centre on the cornea (54) from an axis running parallel to the laser-beam direction which meets the corneal surface at a right angle (z axis), is taken into account, and account is taken of the fact that the energy density F of the emitted laser-beam spot of radius r_s is reduced to F/kl(r), in the case of a cornea assumed to be hemispherical with radius R, when incident on its curved surface (54), where

$$\cancel{kl(r) =} \frac{A_{eff}(r)}{A_0} = \frac{A_{eff}(r)}{\pi \cdot r_2 2} \qquad k1(r) = \frac{A_{eff}(r)}{A_0} = \frac{A_{eff}(r)}{\pi \cdot r_s^2}$$

and

$$A_{eff}(r) = \int_{-rs}^{rs} \int_{\sqrt{rs^2 - x^2} + r}^{\sqrt{rs^2 - x^2} + r} \sqrt{1 + \left(\frac{d}{dx} f(x,y)\right)^2 + \left(\frac{d}{dy} f(x,y)\right)^2}\, dxdy$$

with

$$z = f(x,y) = f(r) = \sqrt{R^2 - x^2 - y^2} = \sqrt{R^2 - r^2},$$

$r = (x^2 + y^2)^{½}$

where x, y, z are the coordinates of the incidence point (58) of the laser-beam spot centre in a Cartesian coordinate system, in which the origin lies at the sphere centre of the cornea which is assumed to be hemispherical.

20. (currently amended) Control program according to claim [[18]] 19, ~~characterised in that~~ wherein the formula is applied for the ablation depth achieved owing to a particular laser-beam spot pulse, in that it is reduced to ~~d·korl(r)~~ d·kor1(r) in relation to the ablation depth d in the case of normal incidence of the laser-beam spot when the laser-beam spot is incident on the curved surface (54), where

$$\cancel{korl(r) =} \frac{\ln\left(\frac{F}{kl(r)F_{th}}\right)}{\ln\left(\frac{F}{F_{th}}\right)} \qquad \underline{kor1(r) = \frac{\ln\left(\frac{F}{k1(r)F_{th}}\right)}{\ln\left(\frac{F}{F_{th}}\right)}}$$

and F_{th} is the energy-density threshold above which ablation takes place, and in that, when generating the control program, this formula is used to adjust the control of the laser beam in accordance with the desired ablation depth.

21. (currently amended) Control program according to claim 19 ~~1 or 18,~~ ~~characterised in that~~ wherein account is also taken of the fact that a fraction of the laser-beam energy incident on the corneal surface is reflected away.

22. (currently amended) Control program according to claim [[18]] 19, ~~characterised in that~~ wherein account is taken of the fact that, in the case of the cornea assumed to be hemispherical, the unreflected fraction of the energy density ~~F/kl(r)~~ F/k1(r) of the laser-beam spot incident on the curved surface is given as (1-k2(r))·F/k1(r), where

$$\cancel{k2(r)=}\frac{q^2(r)+q^2(r)}{2} \qquad k2(r)=\frac{q_\perp^2(r)+q_\parallel^2(r)}{2}$$

with

$$\cancel{q_\cdot(\alpha_1)=}\frac{\sqrt{n^2-\sin^2(\alpha_i)}-\cos(\alpha_i)}{1-n^2} \qquad q_\perp(\alpha_1)=\frac{\sqrt{n^2-\sin^2(\alpha_i)}-\cos(\alpha_i)}{1-n^2}$$

$$\cancel{q_{\shortparallel}(\alpha_1)=}\frac{n^2\cos(\alpha_i)-\sqrt{n^2-\sin^2(\alpha_i)}}{n^2\cos(\alpha_i)+\sqrt{n^2-\sin^2(\alpha_i)}} \qquad q_\parallel(\alpha_1)=\frac{n^2\cos(\alpha_i)-\sqrt{n^2-\sin^2(\alpha_i)}}{n^2\cos(\alpha_i)+\sqrt{n^2-\sin^2(\alpha_i)}}$$

where $\pi/2-\alpha_1$ is the angle between the laser beam and the corneal surface, where

$$\alpha_1(r)=a\tan\left(\frac{r}{\sqrt{R^2-r}}\right)$$ with $0 \leq r^2 < R^2$.

and n is the empirically determined refractive index of the cornea at the wavelength of the laser beam which is used.

23. (currently amended) Control program according to claim 21, ~~characterised in that~~ wherein the formula is applied for the ablation depth due to a particular laser-beam spot pulse, in that it is reduced to d·kor(r) in relation to the ablation depth d in the case of

normal incidence of the laser-beam spot when the laser-beam spot is incident on the curved surface (54), where

$$\cancel{kor(r) =} \frac{\ln\left(\frac{(1-k2(r))\cdot F}{kl(r)\cdot F_{th}}\right)}{\ln\left(\frac{F}{F_{th}}\right)} \qquad \underline{kor(r) = \frac{\ln\left(\frac{(1-k2(r))\cdot F}{k1(r)\cdot F_{th}}\right)}{\ln\left(\frac{F}{F_{th}}\right)}}$$

and F_{th} is the energy-density threshold above which ablation takes place, and in that, when generating the control program, this formula is used to adjust the control of the laser beam in accordance with the desired ablation depth.

24. (currently amended) Control program, according to which a laser-beam spot is guided, while being controlled with respect to position and time, over a cornea to be corrected photorefractively, so as to ablate a predetermined ablation profile therefrom, ~~characterised in that,~~ wherein the effect of the angle between the laser beam and the corneal surface on the fraction of the laser-beam energy incident on the corneal surface which is reflected away is taken into account.

25. (currently amended) Control program, according to which a laser-beam spot is guided, while being controlled with respect to position and time, over a cornea to be corrected photorefractively, so as to ablate a predetermined ablation profile therefrom, wherein the effect of the angle between the laser beam and the corneal surface on the fraction of the laser-beam energy incident on the corneal surface which is reflected away is taken into account,

~~Control program according to claim 24, characterised in that~~ wherein the effect of the distance r of the incidence point (58) of the laser-beam spot centre on the cornea from an axis running parallel to the laser-beam direction, which meets the corneal surface at a right angle (z axis) is taken into account, and account is taken of the fact that, in the

case of the cornea assumed to be hemispherical with radius R, the unreflected fraction of the energy density F of the laser-beam spot incident on the curved surface is given as (1-k2(r))·F, where

, $$\cancel{k2(r) = \frac{q_{\cdot}^2(r) + q_{\cdot\cdot}^2(r)}{2}} \qquad \underline{k2(r) = \frac{q_{\perp}^2(r) + q_{\parallel}^2(r)}{2}}$$

with

$$\cancel{q_{\cdot}(\alpha_1) = \frac{\sqrt{n^2 - \sin^2(\alpha_i)} - \cos(\alpha_i)}{1 - n^2}} \qquad \underline{q_{\perp}(\alpha_1) = \frac{\sqrt{n^2 - \sin^2(\alpha_i)} - \cos(\alpha_i)}{1 - n^2}}$$

$$\cancel{q_{\cdot\cdot}(\alpha_1) = \frac{n^2 \cos(\alpha_i) - \sqrt{n^2 - \sin^2(\alpha_i)}}{n^2 \cos(\alpha_i) + \sqrt{n^2 - \sin^2(\alpha_i)}}} \qquad \underline{q_{\parallel}(\alpha_1) = \frac{n^2 \cos(\alpha_i) - \sqrt{n^2 - \sin^2(\alpha_i)}}{n^2 \cos(\alpha_i) + \sqrt{n^2 - \sin^2(\alpha_i)}}}$$

where $\pi/2-\alpha_1$ is the angle between the laser beam and the corneal surface, where

$$\alpha_1(r) = a\tan\left(\frac{r}{\sqrt{R^2 - r}}\right)$$ with $0 \le r^2 < R^2$.

and n is the empirically determined refractive index of the cornea at the wavelength of the laser beam which is used.

26. (currently amended) Control program according to claim 25, ~~characterised in that~~ wherein the formula is applied for the ablation depth due to a particular laser-beam spot pulse, in that it is reduced to d·kor2(r) in relation to the ablation depth d in the case of normal incidence of the laser-beam spot when the laser-beam spot is incident on the curved surface, where

$$kor2(r) = \frac{\ln\left(\frac{(1 - k2(r)) \cdot F}{F_{th}}\right)}{\ln\left(\frac{F}{F_{th}}\right)}$$

and F_{th} is the energy-density threshold above which ablation takes place, and in that, when generating the control program, this formula is used to adjust the control of the laser beam in accordance with the desired ablation depth.

27. (withdrawn) Method of generating a laser-beam profile which is projected in full ablation or in slit form onto a cornea to be corrected, so as to ablate a predetermined ablation profile therefrom,
characterised in that, when generating the laser-beam profile, the effect of the angle between elementary beams of the laser-beam profile and the corneal surface on the energy density of the elementary beam incidenton the corneal surface and/or on the fraction of the laser-beam energy incident on the corneal surface which is reflected away, is taken into account.

28. (canceled)

29. (currently amended) A control program, according to which a laser-beam spot is guided, while being controlled with respect to position and time, over a cornea to be corrected, so as to ablate a predetermined ablation profile therefrom,
wherein the control program takes into account the effect of the angle between the laser beam (68) and the corneal surface on the energy density of the laser-beam spot incident on the corneal surface,
~~Control program according to claim 1, characterised in that,~~ wherein for the control, and preferably for the time control, account is taken of the fact that the angle between the laser beam and the corneal surface changes during the ablation.

30. (currently amended) Control program according to ~~one of the preceding claims, characterised in that~~ claim 29 wherein the program is configured so that, during the ablation, it can pick up information about the position of the eye with the cornea to be

corrected and, when this position changes, it takes into account the change in the angle between the laser beam and the corneal surface, ~~and/or~~ the change in the effect of this angle on the energy density of the laser-beam spot or elementary laser beam incident on the corneal surface, ~~and/~~or in the effect of this angle on the fraction of the laser-beam energy incident on the corneal surface which is reflected away.

31. (currently amended) Electronic computer (48) for delivering control signals to control a laser beam, ~~characterised in that~~ wherein the computer (48) is programmed with, and runs, a control program to one of claims ~~1, 18 to 34~~ 19-26 or 29.

32. (withdrawn) Device for photorefractive corneal surgery of the eye to correct sight defects, having:

- an instrument (12, 14, 16, 22, 24, 28) for measuring the entire optical system of the eye to be corrected,
- means (48) for deriving an ablation profile from the measured values,
- a laser-radiation source (30) and means (32, 38, 40, 48) for controlling the radiation in accordance with the ablation profile, characterised in that the control means comprise an electronic computer (48) which runs a control program according to one of claims 1, 18 to 34.

33. (withdrawn) Device according to claim 32, in which the electronic computer (48) runs a control program according to claim 11, the local radius of curvature having been determined by the instrument for measuring the entire optical system of the eye to be corrected.

34. (withdrawn) Device according to claim 32 or 33, in which the electronic computer (48) runs a control program according to claim 13, the device having an instrument (28, 42, 44) for determining the position of the eye, which instrument sends information about the position of the eye to the computer (48).

35. (new) A computer readable media including a control program according to which an intensity of a laser-beam is controlled, while being controlled with respect to position and time, over a cornea to be corrected, comprising:

instructions for determining a reduction in an energy density of the laser-beam incident on a corneal surface due to an angle between the laser beam and the corneal surface;

instructions for determining a fraction of the laser-beam energy incident on the corneal surface that is reflected away; and

instructions for adjusting the intensity in response to the determined fraction and reduction.

36. (new) The computer readable media of claim 35 wherein the intensity is adjusted by increasing a number of laser-beam pulses.

37. (new) The computer readable media according to claim 35 wherein the reduction of energy density is determined by calculating the corneal surface that is incident to the laser-beam spot at the angle between the laser beam and the corneal surface, relative to the corneal surface that would be incident to the laser beam spot if the laser beam were normal to the corneal surface.

38. (new) The computer readable media according to claim 35 wherein the fraction of laser-beam energy reflected away is determined by calculating a reflected perpendicular polarized light and a reflected parallel polarized light.

39. (new) The computer readable media according to claim 35 wherein the time interval the laser-beam spot is incident on the corneal surface at an incident point of the corneal surface is increased as a function of the distance of the incidence point of the

laser-beam spot center of the cornea from an axis running parallel to the laser-beam direction which axis meets the corneal surface at a right angle.

40. (new) The computer readable media of claim 39 wherein the energy density F of the emitted laser-beam spot of a radius r_s is calculated as being reduced to F/k1(r), in the case of a cornea assumed to be substantially hemispherical with radius R, when incident on its curved surface (54), where

$$k1(r) = \frac{A_{eff}(r)}{A_0} = \frac{A_{eff}(r)}{\pi \cdot r_s^2}$$

and

$$A_{eff}(r) = \int_{-rs}^{rs} \int_{\sqrt{rs^2 - x^2} + r}^{\sqrt{rs^2 - x^2} + r} \sqrt{1 + \left(\frac{d}{dx} f(x,y)\right)^2 + \left(\frac{d}{dy} f(x,y)\right)^2}\, dxdy$$

with

$$z = f(x,y) = f(r) = \sqrt{R^2 - x^2 - y^2} = \sqrt{R^2 - r^2},$$

$r = (x^2 + y^2)^{½}$

where x, y, z are the coordinates of the incidence point (58) of the laser-beam spot centre in a Cartesian coordinate system, in which the origin lies at the sphere centre of the cornea.

41. (new) The computer readable media of claim 39 wherein an unreflected fraction of the energy density F of the laser-beam spot incident on the curved surface is calculated by the formula (1-k2(r))·F, where

$$k2(r) = \frac{q_\perp^2(r) + q_\parallel^2(r)}{2}$$

with

$$q_{\perp}(\alpha_1) = \frac{\sqrt{n^2 - \sin^2(\alpha_i)} - \cos(\alpha_i)}{1 - n^2}$$

$$q_{\parallel}(\alpha_1) = \frac{n^2 \cos(\alpha_i) - \sqrt{n^2 - \sin^2(\alpha_i)}}{n^2 \cos(\alpha_i) + \sqrt{n^2 - \sin^2(\alpha_i)}}$$

where $\pi/2-\alpha_1$ is the angle between the laser beam and the corneal surface, where

$$\alpha_1(r) = a\tan\left(\frac{r}{\sqrt{R^2 - r}}\right)$$ with $0 < r^2 < R^2$.

and n is the empirically determined refractive index of the cornea at the wavelength of the laser beam which is used.

42. (new) A computer readable media containing a control program, according to which a laser-beam spot is guided, while being controlled with respect to position and time, over a cornea to be corrected, so as to ablate a predetermined ablation profile therefrom, comprising:

instructions for determining a local radius of curvature of the cornea;

instructions for deriving an angle between the laser beam and the corneal surface based in the local radius of curvature of the cornea;

instructions for determining an effect of the angle between the laser beam and the corneal surface on the energy density of the laser beam spot incident on the corneal surface; and

instructions for determining an effect of the angle between the laser beam and the corneal surface on the fraction of the laser-beam energy incident on the corneal surface which is reflected away.

43. (new) The computer readable media of claim 41 where in the local radius of curvature of the cornea is determined by topographical measurement.